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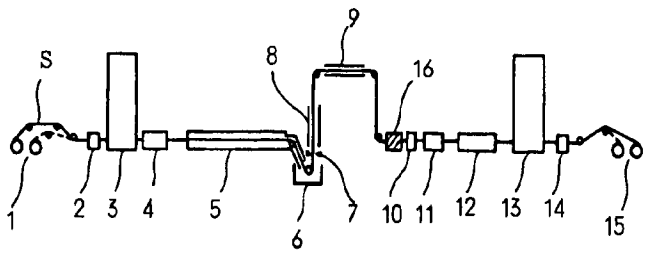
(54) Method of producing galvanized steel sheets having a good workability.

(57) In a method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step and post treatment step for hot dip galvanizing or further paint finishing treatment step, a surface of the resulting galvanized layer is subjected to a brushing treatment with a metal wire brush at the post treatment step.

FIG_1



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BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a method of producing galvanized steel sheets having a good workability, and proposes a technique of reinforcing a galvanized layer effective for preventing the cracking of the galvanized layer at a worked portion.

Moreover, the term "galvanized steel sheet" used herein means steel sheets each provided at its surface with a hot dip zinc coated layer or hot dip zinc-aluminum alloy coated layer, which layer may contain a small amount of other elements such as magnesium, rare earth metal and so on, as well as painted-galvanized steel sheets each finished at the surface of the galvanized layer with a synthetic resin or laminated with a synthetic resin film. Further, the form of the galvanized layer may be spangle or minimized spangle steel sheets.

DISCLOSURE OF RELATED ART

In general, it is known that when the galvanized steel sheet or hot dip zinc-aluminum coated steel sheet is subjected to a bending work, the cracking is caused in the galvanized layer at the bending position and hence the corrosion resistance after the working is considerably deteriorated. Such a phenomenon is observed in the case of painted-galvanized steel sheets obtained by forming the coating layer of the synthetic resin on the galvanized layer of the sheet. That is, the cracking caused on the underground galvanized layer in the working is propagated to the coating layer, whereby the cracking is caused in the coating layer to considerably degrade the corrosion resistance in the worked portion.

Therefore, it is usual to exclude the worked portion from the steel sheet for the guarantee of corrosion resistance. However, it has been desired to guarantee galvanized steel sheets inclusive of the worked portion as a whole.

Under such circumstances, there have hitherto been proposed a method wherein the galvanized layer of the galvanized steel sheet is subjected to a light cold rolling and further to recrystallization heating treatment (Japanese Patent laid open No. 58-84963), a method wherein the surface of the galvanized layer is subjected to blasting treatment (Japanese Patent laid open No. 59-6363 and No. 62-60853) and the like.

In the conventional former technique, however, the rolling mill and the annealing furnace should be arranged back the galvanizing device, so that the equipmental cost becomes excessive and also the occurrence of cracking in the galvanized layer at the worked position can not sufficiently be prevented.

In the conventional latter technique, when the blasting device is arranged in a line, there are many technical obstructions, so that it is not actually put into practical use. That is, in case of arranging the blasting device in the continuous hot dip galvanizing line, a large-scale equipment is required for the sieving cycle of shot particles and there is a fear of remaining component of the shot particle on the surface of the product, so that it is difficult to completely prevent this problem.

Moreover, the thinning of the galvanized layer is known as another method of improving the workability of the galvanized layer, which has such a fundamental drawback that the sufficient corrosion resistance is not obtained.

SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to develop a method effective for preventing the cracking of the galvanized layer at the worked position without causing the aforementioned problems in the light cold rolling or the blasting.

In order to achieve the above object or to prevent the degradation of the corrosion resistance of the worked portion in the galvanized steel sheet, it is necessary to prevent the occurrence of cracking in the galvanized layer at the worked position in the working of the galvanized steel sheet, whereby the corrosion resistance of the bending worked portion can be made almost equal to that of the non-worked portion.

The inventors have made various studies with respect to the production method of galvanized steel sheets not causing the cracking in the galvanized layer during the bending work. As a result, it has been found that when the surface of the galvanized layer in the galvanized steel sheet is subjected to a brushing treatment with a metal wire brush, the workability of the galvanized layer is considerably improved and the cracking in the galvanized layer due to the usual bending work can be prevented sufficiently.

Further, it has been found that even when the synthetic resin having excellent corrosion resistance is applied to the galvanized layer or the film of synthetic resin is laminated on the galvanized layer to form a painted-galvanized steel sheet having a so-called coating layer, there is no cracking in the galvanized layer on the base sheet and no propagation thereof and hence steel sheets having excellent corrosion resistance at the worked portion are obtained.

According to a first aspect of the invention, there is the provision of a method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step and post treatment step for hot dip galvanizing, which comprises subjecting a surface of a galvanized layer to a brushing treatment with a metal wire brush at said post treatment step.

According to a second aspect of the invention, there is the provision of a method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step, post treatment step for hot dip galvanizing and paint finishing treatment step with a synthetic resin on a surface of a galvanized layer, which comprises subjecting said surface of the galvanized layer to a brushing treatment with a metal wire brush at said post treatment step.

According to a third aspect of the invention, there is the provision of a method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step, post treatment step for hot dip galvanizing and paint finishing treatment step with a synthetic resin on a surface of a galvanized layer, which comprises subjecting said surface of the galvanized layer to a brushing treatment with a metal wire brush at said paint finishing treatment step.

The hot dip galvanized steel sheet of the above structure according to the invention is anyone of galvanized steel sheet, hot dip zinc-aluminum alloy coated steel sheet, and paint-galvanized steel sheet provided at the surface with a coating layer of synthetic resin.

According to the invention, a metal brush roll obtained by providing metal or alloy wires of not less than 0.05 mm in diameter such as stainless steel wire, piano wire, brass wire or the like on a surface of roll drum is used as the metal wire brush.

The brushing treatment is preferably carried out by pushing the metal brush roll rotating at not less than 300 rpm onto the surface of the galvanized layer, whereby plastic deformation is given to the galvanized layer. Moreover, the rotating speed is not limited to the above value because it is dependent upon the roll diameter.

In a preferred embodiment of the invention, the brushing treatment is carried out by arranging the metal brush roll at any position ranging from the solidification of hot dip galvanizing metal to the coiling thereof in the post treatment step for the galvanizing.

In the above construction of the invention, the metal brush roll is arranged between the cooling device and the skin pass rolling mill in the post treatment step for the galvanizing.

In another preferred embodiment of the invention, the brushing treatment is carried out by arranging the metal brush roll in the paint finishing treatment step.

In the above construction of the invention, the metal brush roll is arranged between the pay-off reel and the paint preliminary treating device in the paint finishing treatment step.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic view showing an outline of a continuous hot dip galvanizing installation; and
Fig. 2 is a schematic view showing an outline of a continuous paint finishing line.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is a method of brushing the surface of the galvanized layer. The reason why the occurrence of the cracking in the bend-worked portion of the galvanized layer is prevented by brushing the surface of the galvanized layer is considered as follows. That is, when the surface of the galvanized layer is subjected to the brushing treatment, mobile dislocations are introduced into the galvanized layer, whereby it is considered that the galvanized layer easily creates plastic deformation. According to the inventors' experience, the occurrence of cracks is disappeared by the brushing treatment of the galvanized layer even in the bending work.

According to the method of the invention, the workability of the galvanized layer is improved by subjecting the surface of the galvanized layer in the hot dip galvanized steel sheet, which is immersed in and passed through a hot dip galvanizing bath or a hot dip zinc-aluminum alloy coating bath, to a brushing treatment with a metal wire brush.

Such a brushing treatment is carried out at a post treatment step after the galvanizing or at a subsequent paint finishing step. In the former case, the metal wire brush is arranged in any position ranging from the solidification of the hot dip galvanizing metal to the coiling thereof, while in the latter case, the metal wire brush is arranged in any position at the pain finishing step.

The arranging position of the metal wire brush is between the cooling device and the skin pass roll or leveler roll at the post treatment step after the galvanizing. The reason on the limitation of such a position is due to the fact that the plastic deformation can not be given to the galvanizing metal before the solidification and the surface of the galvanized metal somewhat roughened by the brushing treatment can be tempered by skin pass treatment. The galvanized steel sheet subjected to the brushing treatment may be rendered into a product after chromate treatment.

Furthermore, when the painted-galvanized steel sheet is produced as another preferred embodiment, the coating layer is formed at the paint finishing step after the brushing of the galvanized layer at the post treatment step for the galvanizing, or the brushing treatment is conducted at the paint finishing step followed by the post treatment step. In this case, a synthetic resin such as polyester resin, epoxy resin, fluorocarbon resin, vinyl chloride resin or the like is applied onto the galvanized layer, or a film of the above synthetic resin is laminated on the galvanized layer to form a coating layer, whereby a painted-galvanized steel sheet can be obtained.

In the above embodiment, the metal wire brush is arranged between a pay-off reel and a preliminary treatment device for paint at the paint finishing step, whereby the brushing treatment may be conducted. More preferably, the brushing treatment may be conducted between a looper roll at entrance side and a degreasing-washing device in the paint finishing line. The reason on the limitation of such a position is due to the fact that when the brushing treatment is conducted after the preliminary treatment for paint, the preliminarily treated film is broken, while when the metal wire brush is located at the back of the entrance-side looper roll, there is no influence of line rate to the treatability and also the impurity is easily removed by the degreasing and washing.

The generally known brushing treatment is conducted in the washing line for the removal of contaminant from the surface of the steel sheet or the surface activation. Such a general brushing treatment is used for rubbing surface contaminant with, for example, a nylon brush, or for removing surface oxide and the like by polishing with a nylon brush containing grindstones. However, these brushes used in the preliminary treatment for a so-called surface treatment do not develop the effect of causing plastic deformation on the galvanized layer to improve the workability of the galvanized layer as in the invention.

In the invention, therefore, it is required to use the metal brush instead of the nylon brush. For example, hard metal or alloy wires such as stainless wire, piano wire, brass wire and the like may be used in the metal brush. In this case, when the diameter of the wire is too fine, the brushing effect is lost, so that the diameter of the wire constituting the brush body is not less than 0.05 mm, preferably 0.2-0.5 mm. Further, in order to conduct the brushing treatment with the metal wire brush in the production line, it is effective to stand metal wires having a length of about 50-150 mm onto a roll drum to form a metal brush roll. Moreover, when the rotating rate of the metal brush roll is too small, there is obtained no effect, so that the rotating rate is preferably not less than 300 rpm, more preferably 800-3000 rpm. In addition, it is preferable to rotate the metal brush roll under a light pushing force.

These conditions for the metal brush roll are important to give a proper plastic deformation to the surface of the galvanized layer. If the brushing treatment with the metal brush roll is carried out outside the above conditions, the effect of improving the desired workability of the galvanized layer is not obtained.

The following examples are given in the illustration of the invention but are not intended as limitations thereof.

In Fig. 1 is shown an outline of the continuous hot dip galvanizing line according to a first embodiment of the invention. A preliminary treatment step for galvanizing located at an upstream side of the continuous hot dip galvanizing line is a step that a steel sheet S delivered from a pay-off reel 1 is transferred to an annealing furnace 5 through a welder 2, an entrance-side looper 3 and a degreasing and washing device 4 and heated in a reducing atmosphere. The thus surface-activated steel sheet is passed through a hot dip metal pot 6 in the galvanizing step to adhere a hot dip metal to the surface of the steel sheet and then passed through a wiping nozzle 7 to adjust the weight to be adhered. In the post treatment step for the galvanizing, the galvanized steel sheet is passed through an alloying furnace 8 or a minimized spangle forming device, if necessary, and then wound on a coiler 15 through a cooling device 9, a skin pass rolling mill 10, a leveler 11, a phosphating tank 12, a delivery-side looper 13 and a shearing machine 14.

In the illustrated embodiment, a metal brush roll 16 made from metal or metal alloy wires is arranged at an adequate position ranging from solidification of the hot dip galvanized metal to the delivery-side looper in the above post treatment step for the galvanizing in the continuous hot dip galvanizing line. In Fig. 1 is shown an arrangement of the metal brush roll between the cooling device 9 and the skin pass rolling mill 10.

In Fig. 2 is another embodiment of the invention, in which a continuous paint finishing step starting from a pay-off reel 21 is arranged at the back of the coiler 15 in the aforementioned post treating step for the galvanizing. In a first half of this paint finishing step, the steel sheet S delivered from the pay-off reel 21 is transferred to a preliminary treatment device for painting through a welder 22, an entrance-side looper 23 and a degreasing and washing device 24, at where the steel sheet is subjected to a treatment with a phosphate or chromate. Then, the thus surface-activated steel sheet is passed through an undercoating device 26, a baking device 27, a top coating device 28 and a baking device 29 to coat the surface of the sheet with a synthetic resin. Thereafter, the paint finished steel sheet is passed through a post treatment device, if necessary, and wound about a coiler 33 through a delivery-side looper 31 and a shearing machine 32.

In the latter embodiment, a metal brush roll 34 made from metal or metal alloy wires may be arranged between the pay-off reel 21 and the degreasing and washing device 24, particularly immediately at the back of the entrance-side looper 23 in the continuous paint finishing treating step.

(1) Example 1: Metal brush rolls 10, 34 having a roll outer diameter of 300 mm and a roll width of 1000 mm and provided with stainless steel wires (SUS 304) having a diameter of 0.3 mm were arranged at the back of the cooling device 9 in the post treatment step of the continuous hot dip galvanizing apparatus shown in Fig. 1 and at the back of the entrance-side looper 23 in the continuous paint finishing line shown in Fig. 2, respectively. These metal brush roll was rotated at 1500 rpm and pushed onto the surface of the galvanized layer to conduct brushing treatment. Moreover, the metal brush rolls arranged in the above lines could be escaped from these lines, so that the galvanizing was conducted without the brushing treatment for comparison.

Various hot dip galvanized steel sheets, and painted-galvanized steel sheets coated with polyester resin were manufactured by varying conditions such as thickness of steel sheet, composition of the galvanized layer, galvanizing amount, size of spangle and the like. Then, the change of workability was examined in the presence or absence of the brushing treatment at the post treatment step or the paint finishing step. Moreover, the workability was judged by observing a bent portion after 0t bending by means of a loupe according to a judgement standard as shown in table 1.

In Table 2 are shown results evaluated on the workability in the galvanized steel sheets and paint finished steel sheets coated with the synthetic resin.

Table 1

	Judgement standard of workability
1	cracking is conspicuous, separation locally is observed
2	large cracking is observed over full surface
3	cracking is substantially observed over full surface
4	small cracking is locally observed
5	no cracking is observed

Table 2 Change of workability in galvanized steel sheets and paint finished galvanized steel sheets in the presence or absence of brushing treatment

Kind of galvanizing metal	Thickness (mm)	Amount adhered g/m²	Spangle	Brushing treatment	Workability of galvanized sheet	Workability of paint finished sheet	
						*1	*2
GI	0.22	120	regular	presence	5	5	-
				absence	3	3	-
	0.35	120	minimum	presence	5	5	5
				absence	3	3	3
	0.50	250	minimum	presence	5	4	5
				absence	3	3	3
	1.80	250	regular	presence	4	4	-
				absence	3	3	-
GF	0.35	180	regular	presence	5	5	5
				absence	4	4	4
	0.40	250	regular	presence	5	5	5
				absence	3	3	3
GL	0.27	150	regular	presence	3	4	-
				absence	2	2	-
	0.40	150	regrlar	presence	3	4	-
				absence	2	2	-

Note: The amount galvanizing metal adhered means an amount adhered to both surface of the sheets

*1: Brushing treatment is carried out at the post treatment step for hot dip galvanizing

*2: Brushing treatment is carried out at the paint finishing treatment step

As seen from the above results, the effect of the galvanized steel sheets according to the invention is remarkable; that is, the workability is considerably improved by the brushing treatment. Further, it is obvious that the similar results are always recognized even when the galvanizing is usual galvanizing (GI), hot dip Zn-5% Al alloy coating (Galfan; GF) or hot dip Zn-55% Al alloy coating (Galvalume; GL), or even when the thickness, galvanizing amount or spangle shape is varied, or even when the synthetic resin is applied to or the film of the synthetic resin is laminated onto the surface of the galvanized layer.

As mentioned above, according to the invention, the workability of the galvanized layer in the galvanized steel sheets is improved, and particularly no cracking is caused in the worked portion of the galvanized layer even when the galvanized layer is subjected to a bending work, so that galvanized steel sheets and painted-galvanized steel sheets having considerably improved corrosion resistance can be produced.

Claims

1. A method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step and post treatment step for hot dip galvanizing, which comprises subjecting a surface of a galvanized layer to a brushing treatment with a metal wire brush at said post treatment step.

2. The method according to claim 1, wherein said galvanized layer is a hot dip zinc coating or hot dip zinc-aluminum alloy coating.

3. The method according to claim 1, wherein as said metal wire brush is used a metal brush roll obtained by providing metal or alloy wires of not less than 0.05 mm in diameter selected from stainless steel wire, piano wire and brass wire on a surface of roll drum.

4. The method according to claim 3, wherein said metal brush roll is pushed onto the surface of the galvanized layer while rotating at not less than 300 rpm to give plastic deformation to the galvanized layer.

5. The method according to claim 3, wherein said metal brush roll is arranged at any position ranging from solidification of the hot dip galvanizing metal to coiling thereof at the post treatment step for the galvanizing.

6. The method according to claim 3, wherein said metal brush roll is arranged between a cooling device and a skin pass rolling mill at the post treatment step for the galvanizing.

7. A method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step, post treatment step for hot dip galvanizing and paint finishing treatment step with a synthetic resin on a surface of a galvanized layer, which comprises subjecting said surface of the galvanized layer to a brushing treatment with a metal wire brush at said post treatment step.

8. The method according to claim 7, wherein said coating layer is formed by applying a synthetic resin or by laminating a film of a synthetic resin.

9. The method according to claim 7, wherein said galvanized layer is a hot dip zinc coating or hot dip zinc-aluminum alloy coating.

10. The method according to claim 7, wherein as said metal wire brush is used a metal brush roll obtained by providing metal or alloy wires of not less than 0.05 mm in diameter selected from stainless steel wire, piano wire and brass wire on a surface of roll drum.

11. The method according to claim 10, wherein said metal brush roll is pushed onto the surface of the galvanized layer while rotating at not less than 300 rpm to give plastic deformation to the galvanized layer.

12. The method according to claim 10, wherein said metal brush roll is arranged at any position ranging from solidification of the hot dip galvanizing metal to coiling thereof at the post treatment step for the galvanizing.

13. The method according to claim 10, wherein said metal brush roll is arranged between a cooling device and a skin pass rolling mill at the post treatment step for the galvanizing.

14. A method of producing galvanized steel sheets having a good workability through preliminary treatment step for hot dip galvanizing, hot dip galvanizing treatment step, post treatment step for hot dip galvanizing and paint finishing treatment step with a synthetic resin on a surface of a galvanized layer, which comprises subjecting said surface of the galvanized layer to a brushing treatment with a metal wire brush at said paint finishing treatment step.

15. The method according to claim 14, wherein said coating layer is formed by applying a synthetic resin or by laminating a film of a synthetic resin.

16. The method according to claim 14, wherein said galvanized layer is a hot dip zinc coating or hot dip zinc-aluminum alloy coating.

17. The method according to claim 14, wherein as said metal wire brush is used a metal brush roll obtained by providing metal or alloy wires of not less than 0.05 mm in diameter selected from stainless steel wire, piano wire and brass wire on a surface of roll drum.

18. The method according to claim 17, wherein said metal brush roll is pushed onto the surface of the galvanized layer while rotating at not less than 300 rpm to give plastic deformation to the galvanized layer.

19. The method according to claim 17, wherein said metal brush roll is arranged between an entrance-side pay-off reel and a preliminary treating device for painting at the paint finishing treatment step.

FIG_1

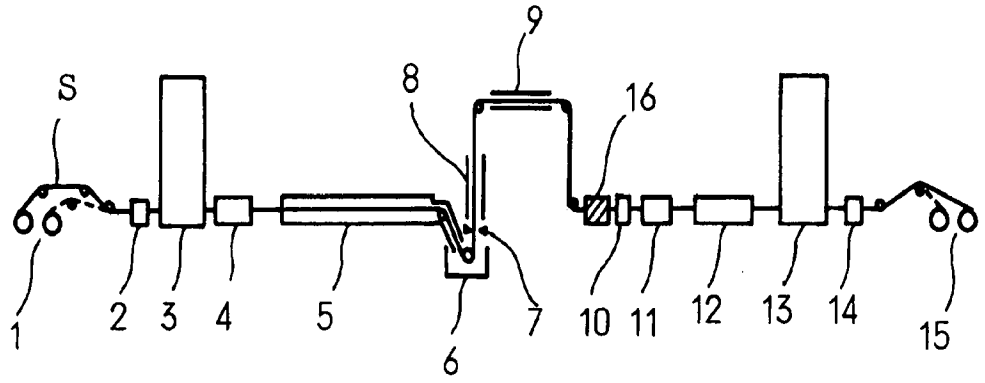
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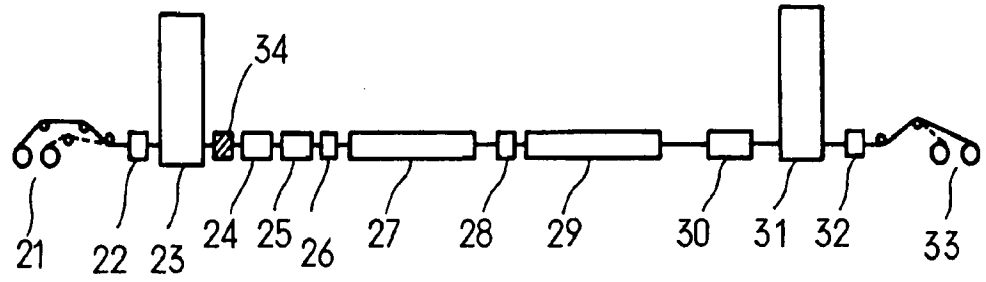
FIG_2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